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Hedging Jordanian Oil Purchases' Price Risk and Costs Using Oil Futures Contracts During 1998-2007

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Abstract

This study aims to investigate whether using futures contracts will reduce the Jordanian imported petroleum price risk and decrease the Jordanian petroleum purchases invoice. To achieve the objectives of this study, ten years-hedge simulation conducted on the real imported quantities to generate assumed comparable cases for the unhedged and hedged costs of the Jordanian monthly purchases.

The study sample consisted of Jordanian monthly imported quantities of crude oil during the 1998-2007 period. Weekly spot prices of Saudi Arabian Light Crude and the daily futures prices of NYMEX Cushing Crude Oil Futures Contracts 1 (one month) and 4 (4 months) were also used.

Constant cross hedge strategy conducted for hedging the Jordanian imported petroleum needs. The NYMEX Cushing Crude Oil Futures Contracts 1 and 4 employed to hedge the Saudi Arabian light crude oil over the study period as a proxy for the Jordanian petroleum purchases. The results demonstrate that the constant cross hedge strategy with the NYMEX oil futures contract 4 proved to be successful in hedging the price risk of the Jordanian imported petroleum and decreases the purchases invoice. While that of NYMEX oil futures contract 1 increases the price risk of the Jordanian imported petroleum, but at the same time decreased the purchases invoice. The researchers recommend the energy policymakers in Jordan to assess the merits of futures contracts in the oil futures for managing risks related with the petroleum price risk. The researchers also recommend studying the effect of other derivatives tools such as option futures on managing the Jordanian oil price risk or employing other different futures contracts maturities like six, nine months and one year in different oil markets such as Dubai Mercantile Exchange.

Keywords: Oil, futures contracts, risk management, hedging strategies, Jordan, oil price volatility, oil purchases cost.

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تحويط المخاطر السعرية وتكاليف المشتريات الأردنية من النفط
باستخدام عقود المستقبليات خلال الفترة 1998-2007

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ملخص

تهدف هذه الدراسة لمعرفة مدى ملاءمة العقود المستقبلية في تحويط مشتريات الأردن من النفط ضد مخاطر تقلب أسعار الطاقة العالمية، وكذلك معرفة مدى قدرة هذه العقود في تخفيض قيمة فاتورة مشتريات النفط الأردنية وذلك للفترة 1998-2007، ولتحقيق هذا الهدف قام الباحثان بإجراء محاكاة لتحويط المشتريات الأردنية الشهرية للنفط المستورد خلال مدة الدراسة.

تضمنت عينة الدراسة الاحتياجات الشهرية الأردنية المستوردة من النفط الخام لتلك المدة والأسعار الأسبوعية الحاضرة للخام العربي السعودي بالإضافة لأسعار العقود المستقبلية للخام الأمريكي في سوق NYMEX، ثم استكملت بيانات الدراسة من شركة مصفاة البترول الأردنية وإدارة معلومات الطاقة الأمريكية. اعتمدت في هذه الدراسة إستراتيجية التحويط المتقاطعة الثابتة باستخدام عقد 1 وعقد 4 للخام الأمريكي الخفيف في سوق NYMEX لتحويط الخام العربي السعودي الخفيف في ضوء المشتريات الشهرية الأردنية الشهرية من الخام الخفيف. أشارت نتائج الدراسة إلى أن استخدام العقود المستقبلية للخام الأمريكي الخفيف في سوق NYMEX يمكنه أن يؤدي إلى تقليل التقلب في أسعار المشتريات الأردنية من النفط وبالتالي تخفيض كلفة الفاتورة النفطية، إلا أن ذلك ينطبق فقط على العقد رقم 4 ، حيث بينت النتائج إلى أن استخدام العقد رقم 1 للخام الأمريكي الخفيف من شأنه أن يزيد من مخاطر تقلب أسعار المشتريات الأردنية من النفط ولكنه يعمل على تخفيض حجم التكاليف الكلية لفاتورة النفط المستورد.

يوصي الباحثان الجهات المختصة في مجال الطاقة بالأردن إلى دراسة مزايا ومساوئ استخدام العقود المستقبلية في مجال إدارة مخاطر أسعار النفط، كما يوصي الباحثان بضرورة إجراء مزيد من الدراسات حول جدوى استخدام الأدوات المالية المشتقة ومدى ملاءمتها للاحتياجات المحلية، فضلا عن استخدام عقود مستقبليات النفط ولكن بآجال ستة، تسعة شهور وسنة واحدة في أسواق مختلفة مثل سوق دبي للسلع (DME).

الكلمات الدالة: أسعار النفط، عقود المستقبليات، إدارة المخاطر، استراتيجيات التحويط، الأردن، تقلب أسعار النفط، تكاليف مشتريات النفط.

1. Introduction and Problem Definition

Because Jordan has no significant oil[1] resources of its own, and because it is relying fully on imported oil for all its needs, Jordan now has to purchase oil at the World market price, which has been a drain on the country's current account balance.

In the light of these reasons, Jordan and many other countries will be more exposed to oil price volatility and there will be many scenarios for negative effects. That's why the decision makers in the imported energy in Jordan have to work continuously to find solutions that enables the Jordanian government to manage and avoid this sort of risk

Recently, there is a new global trend of using financial derivatives in hedging different kind of risks as it indicated by the daily financial reports. This modern financial field (sometimes called financial engineering) proved to be one of the most suitable solutions for a wide sectors in risk management and guide different individual and institutional investors in mitigating the uncertainty conditions associated with their positions in the commodity and financial markets.

This study will investigate the extent of using futures contract's hedging strategies to manage the petroleum price risk in Jordan. This study seeks to answer the following questions:

1- What is the effect of applying *cross* hedge strategy with futures contract on the Jordanian petroleum purchases?

2- What is the effect of applying *constant* hedge strategy with futures contract on the Jordanian petroleum purchases?

3- Should the usage of futures contracts reduce the petroleum price risk associated with the Jordanian needs of petroleum?

4- What is the usage impact of futures contracts on the costs of Jordanian imported petroleum?

5- What is the most appropriate maturity of futures contracts to apply in the Jordanian petroleum context?

2. Study Objectives and Hypotheses

The aim of this study is to propound a solution for the current problem facing Jordan in managing the oil price volatility. In other words, the study will try to achieve the following:

1- Examine the hedging strategies of the Jordanian purchases of petroleum against price volatility by using futures contracts.

2- Examine the impact of hedging Jordanian petroleum purchases on the cost of Jordanian petroleum invoice.

3- Provide the energy policymakers in Jordan with information for the assessment of the merits of futures contracts for managing risk related with the petroleum price risk.

4- Exploiting the cross-hedge and constant-hedge strategies which considered the most important strategies of financial engineering to avoid the petroleum price risk and reduce the amount of imported petroleum costs.

Based on the literature review and the objectives of the study, the researchers stated the following hypotheses:

First Hypothesis: Using Cushing OK Crude Oil Futures Contract 1 will reduce the volatility of the Jordanian petroleum purchases.

Second Hypothesis: Using Cushing OK Crude Oil Futures Contract 1 will reduce the cost of Jordanian imported petroleum.

Third Hypothesis: Using Cushing OK Crude Oil Futures Contract 4 will reduce the volatility of the Jordanian petroleum purchases.

Fourth Hypotheses: Using Cushing OK Crude Oil Futures Contract 4 will reduce the cost of Jordanian imported petroleum

3. Study Importance

As far as the researchers know, this study will be the first in Jordan that examine one of the most important issue which concern with Jordanian petroleum purchases . Also the importance of the study stems from:

1- The exploration of the important role of the futures markets in price risk management. Using these markets for hedging is a notion that is just now beginning to gain acceptability among developing countries, Jordan would be one of the first.

2- The underlying asset of the futures contracts in this study is oil, which is considered the most important and expensive product for most developed and developing countries. This study will investigate the usefulness of different financial tools and futures contracts in managing the price risk and whether these strategies can lower the oil invoice especially for the Jordanian economy.

3- Most previous literature have investigated hedging oil price risk from the oil exporter point of view. Very few researches, however have focused on oil imports or end-users. The study hopes to contribute in bridging this gap.

4- The premises of this study could be extended to other strategic commodities such as natural gas; main corps and industrial raw material, and will open the door to investigate other financial tools and strategies.

4. Theoretical Background and Literature review

4.1. Basic Definitions :In the financial literature there are two types of financial tools: the fundamental or underlying assets and the derived tools or assets. The existence of the first type is the origin of the second and its payoffs and value are derived from, or depend on it (Ross et al.,2005:696). There are four basic kinds of derivatives: options; swaps; forwards and futures. They are known as the basic *building blocks* because they are used to build more combination derivatives. This study is concentrating on using futures contracts in managing price risk.

4.1.1 Futures Contract: is a commitment to deliver a certain amount of a specified item at a specified date at a price agreed upon at the time the contract is sold (Gitman and Joehnk,1999,459). Others defied the financial futures as an agreement reached today between a buyer and a seller that calls for delivery of a particular security in exchange for cash at some future date (Ross and Hudgins, 2008:248).

Most financial and real assets transactions occur in what is known as the spot, or cash market, where the asset is delivered immediately or within a few days (Brigham and Daves, 2004: 825). When a contract of 1000 barrel (standard size of spot and futures contract) of oil is sold, the transaction takes place in the cash market and the delivery process will be immediate.

However, a contract of 1000 barrel of oil could also be sold in the futures market. In that market, the contract seller would not actually deliver the barrels until some mutually greed-upon date in the future (called the maturity date) because he has a legally binding obligation to make delivery of the stated quantity of oil on a specified date in the future. At the same time, the contract buyer has a similar obligation to take delivery of the same quantity of oil at the agreed upon fixed price. Of course, the two parties of the transaction will avoid any undesirable swing in the underlying asset price in the future. In the real world, very few futures contracts involve actual delivery at maturity. Rather, buyers and sellers of a certain contract independently take offsetting positions to close out their contracts. The seller cancels a contract by buying back another contract with the same features and vise versa for the buyer by selling another contract. As a result, only a small percentage of contracts come to actual delivery (Van Horne, 2002: 648).

4.1.2 Hedging: As far as the spot positions owners have control on price volatility, they will enhance their success chance in the future. However, there are difficulties to estimate the size of that risk; time of its occurrence; and shape of its influence ,so managers have to hedge their positions by using derivatives, especially futures contracts.

Typically, the ordinary transactions is conducted in the spot market, whereas the futures contracts transactions is conducted in futures markets. When any party deals with spot markets, he will take a particular position in that market, that is the party who does not currently own the underlying asset and intends to buy it in the future, he is taking a short position in spot market. Whereas, the party who currently owns the underlying asset and intends to sell it in the future, he is taking a long position in spot market. In the futures market, the scene is difficult, the short position holder in the spot market will be a long position holder in futures market, whereas the long position holder in spot market will be a short position holder in futures market.

If any party hedged against the price risk by futures, he will be taking two different (opposite) positions at the same time, one of them is basically the party's position in the spot market, and the other will emerge from the party's position in the futures market as a result of the hedging process. After that the hedger will be waiting the two positions outcome. Certainly, if one of the two positions will achieve profits, the another position will achieve losses and vise versa.

4.1.3 Perfect and Cross Hedging

When the hedger decides to take a futures position in the futures market, he has to choose either taking the asset underlying the futures contract as the hedged asset *(perfect hedging)*, or taking the asset underlying the futures contract to be different from the hedged asset *(cross hedging)*. To perform the perfect hedge there is a symmetry condition in the underlying asset, the amount of the asset; and the maturity date (Al-Joubori,2002: 59). Any imperfection in that conditional requirements make hedging works less than perfectly. In practice the following are a number of reasons for that imperfect hedging:

1- The asset whose price is to be hedged may not exactly the same asset underlying the futures contract.

2- Hedgers may be uncertain as to the exact date when the asset will be bought or sold.

3- The hedge may require the futures contract to be closed well before its maturity date.

With perfect hedge, the hedger certainly achieve net profit (loss) equal zero i.e., the hedger completely eliminates the risk. Perfect hedges in reality are rare. Most hedge are imperfect for the above reasons but often because the hedger does not typically hold the position to expiration (Chance, 2004: 350). For the most part, therefore, a study of hedging using futures is a study of the ways in which hedges can be constructed so that they perform as close as possible (Hull, 2008: 45).

The fulfillment of the perfect hedges requirement is too difficult ,particularly, when there is no futures contracts on the underlying asset which the hedger wants to make protection against its price risk. For example, airlines companies sometimes use the New York Mercantile Exchange (NYMEX) heating oil futures to hedge their exposure to the price of jet fuel (Hull, 2008: 56). The success of this kind of hedging necessitate strong relationship between the price of the asset underlying the futures contract and the price of the asset being hedged[(2)].

4.1.4 Hedge Ratio

The hedge ratio is the ratio of the size of the position taken in the futures contract to the size of the exposure. In the perfect hedge there is no problem in determining the number of the contracts that are needed to hedge the spot position in the market. But when cross hedging is used, setting the hedge ratio equal 1.0 is not always feasible or optimal. The hedger should choose a value for the hedge ratio that minimize the variance of the value of the hedged position, that's why it called (*the minimum variance hedge ratio*), so one objective of this study is to find the number of oil futures contract that gives the minimum value for the variance of hedge performance.

4.2 Petroleum Price Risk

Petroleum is considered one of the most important commodity in the world, and there are quite huge number of reasons that may cause continuous volatility in its price such as world economic growth; political conflicts; weather; seasonal patterns; wars and regional refining capabilities. Generally, energy prices vary more than the prices of other commodities, historical price data clearly illustrate the relatively high volatility of energy prices (Lee and Zyren, 2002:10).

World oil traders use several locations and types of crude oil as pricing benchmarks. The price of West Texas Intermediate (WTI), a light sweet (low sulfur) crude oil at Cushing, Oklahoma, is used as a principal pricing benchmark for spot trading in the Unites States, WTI is that crude oil which meets the NYMEX sweet crude specifications for delivery at Cushing. In Europe the crude product is North Sea Brent (Hale,2002: 16). The third major crude product is Dubai, representing the product shipped from the Arabian Gulf.

Each of these three products will trade in close relation to each other, generally reflecting their slightly different quantities and the transport cost (Thain, 2000:526).

4.3 Petroleum Futures Markets and Hedging

Oil producers look for avoiding any decline in crude prices, consequently, they in advance, sell their product to (users and end-users) who in turn, want protection against prices increase. Refinery owners search for protection from low product

prices, and they sell to storage facilities and customers who are concerned about high prices. At each stage, suppliers and purchasers can split the risk in order to allay their concern. Risk managers in the petroleum and natural gas industries commonly use derivatives to achieve certainty about the prices they pay or receive (EIA, 2000: 20).

The NYMEX and the International Petroleum Exchange (IPE) trade a number of oil futures and oil futures option contract(3). Recently, in the Arabian region, Dubai Mercantile Exchange (DME) is set to trade energy futures exchange in the Middle East. Some of the futures contracts are settled in cash; others are settled by physically delivered. For example, the Brent crude oil futures traded in the IPE has cash settlement; the light sweet crude oil futures traded on NYMEX and Oman crude oil futures require physical delivery. These exchanges and the Over The Counter (OTC)(4) traders have designed derivatives that respond to the concerns of market participants. NYMEX has become the dominant market for energy futures and options trading. The largest contract by volume is the light sweet crude oil futures contract, which began trading in 1983. To a large extent, the OTC market exist to bridge the gap between exchange–traded products and the needs of individual traders, so that the two markets in effect have a symbiotic relationship (EIA,2000: 23).

4.4 Previous Studies

There are many studies conducted in this field, unfortunately most of these studies are referring to hedging the petroleum producers positions rather than end users. The following are reviews some of these studies:

Ripple and Moosa, 2007 examined the effect of the maturity of the futures contract used as the hedging instrument on the effectiveness of futures hedging. For that purpose, daily and monthly data on WTI crude oil futures and spot prices are used to work out the hedge ratios and to measure the hedging effectiveness resulting from using the near-month contract and those resulting from the use of a more distant (6-months) contracts. The empirical results revealed that futures hedging is more effective with the near-month contract, rather than with distant contract, is used for hedging a spot position on crude oil. The results also revealed that hedge ratio are lower for near-month hedging .

Hatemi and Rocab, 2006 demonstrated in their study that in calculating the optimal hedge ratio, it is important to determine whether a static or dynamic model is appropriate model to use. If a time varying coefficient model is called for, it is proposed that the estimation of this is based on the Kalman Filter, as this approach proved to generate the estimated parameters which have better statistical properties. The time path of the estimated hedge ratio can then be analyzed to determine whether or not there is great volatility in the hedge ratio because this

approach will have implications in terms of the costs of rebalancing the hedged positions.

The objective of *Raju,2005* study was to assess the risk management prospects for hedging Ecuadorian oil price risk. The researcher developed a portfolio model of hedging and use it to evaluate the costs and benefits of different hedging strategies over the 1991-96 period. Thereby showing that there are effective risk reducing strategies available to oil revenues over time and provided estimates of the cost and benefits of the different hedging strategies that may aid in policy formulation. The results revealed that in every case, ex-ante hedging was effective in reducing price risk, further, for a risk minimization short hedging, a 1 percent reduction in risk would have cost a reduction in return of 0.65 percent. In sum, the study found that oil futures hedging offers significant risk-reduction potential.

Alizadeh et al., 2004 examined the hedging effectiveness of crude oil, gas oil and heating oil futures contracts in three major shipping ports: Rotterdam; Singapore; and Houston. Hedging performance are examined for each bunker(5) market, considering both constant and dynamic hedge ratios. The results revealed that risk management through cross-market hedging is limited, achieving only up to 43% variance reduction when using IPE crude oil to hedge the price in Rotterdam. Also, hedging effectiveness varies from one market to another. This is because bunker prices although derived from prevailing conditions in the oil market, mainly reflect the balance of supply and demand for bunker fuel in the region. One amazing recommendation of this study is that for agents determined to use futures contracts to hedge bunker price risk, policy makers should use IPE crude oil contracts to hedge bunker price fluctuations when loading in Rotterdam, NYMEX gas oil contracts when loading in Singapore, and IPE gas oil futures contract when using Houston for refueling vessels .

Rahgozar and Najafi, 2003 examined the effect of market diversification, contract maturity and hedging on managing risks. The hedging effectiveness of several hedging models is investigated. The NYMEX and the IPE futures contracts with different maturity dates are employed to hedge the WTI spot price risk. For all the models considered, the dynamic hedging approach generated the best results considering risk reduction. In almost all cases, the IPE futures prices reduced the revenue risk more than NYMEX futures contracts. This imply that in order to diversify risk, US crude prices can be hedged using IPE futures contracts. The estimated hedge ratios under each model differed in value and they also varied depending on the maturity dates of the futures contracts and/or futures market employed. While leaving revenue intact or reducing it slightly, all models reduced risk. The test results confirmed that distant futures contracts and cross-hedging using IPE futures prices are more effective in reducing risk than nearby futures prices and NYMEX futures contracts.

Haushalter, 2000 examined the risk management activities of 100 oil and gas producers in 1992, 1993, and 1994. He attempted to relate the extent of different firms' hedging activity to their capital structure (debt/equity ratio, interest coverage, etc.), tax status, compensation policies, ownership structure, and operating characteristics. He found the followings: Firstly, the presence of hedging activity increased from 43 percent of the firms in the sample in 1992 to 57 percent in 1994. About one-quarter of the firms surveyed hedged more than 28 percent of their production. Hedgers as a group hedged about 24 percent of their total production. Secondly, companies with more assets were more likely to hedge. Thirdly, hedgers with larger proportions of debt in their capital structure hedged a greater fraction of their production. Fourth, hedging was more likely for firms whose local spot market prices closely followed the Henry Hub (natural gas) or Cushing (sweet crude) spot prices used in NYMEX futures. In other words, the lower the basis risk, the more likely a firm was to hedge.

Chen et al., 1987 provided an empirical analysis of the hedging potential of energy futures for three widely traded commodities: crude oil; heating oil and leaded gasoline. They analyzed the ability of energy futures in reducing the price risk of energy products as well as improving the risk return performance of the hedger's position. The results show that energy futures can play a vital role in hedging the oil price volatility faced by producers refiners and end user, also there are a strong correlation between futures price movements and spot prices in the crude oil, heating oil and leaded gasoline markets. The hedging results show that a substantial portion of the price risk can be removed through the use of energy futures while at the same time enhancing the hedger's return.

5. Research Design and Methodology

5.1 Introduction: The main purpose of this study is to investigate whether using futures contracts will reduce the petroleum price fluctuation risk and decrease the Jordanian imported petroleum costs. To achieve the objectives of this study, ten years-hedge simulation will be conducted on the real monthly imported quantities, that aims to generate assumed comparable cases for the unhedged and hedged costs of the monthly needs.

5.2 Simulation Assumptions: The main assumption for hedging simulation are the following: 1- During the study period, Jordan had been supplying its petroleum needs just from Saudi Arabian Light Crude(6) . 2- The monthly deals with Arabian American Oil Company (ARAMCO) hold on a monthly basis, that is at the end of each month Jordan Petroleum Refinery Company contracts with ARAMCO to purchase the petroleum needs of the next month by the spot price at that time, according to that contract ARAMCO stipulate on the Jordanian company to pay the invoice value during one week after delivery at most (General Accounting Cash

Mang., Jordan Petroleum Refinery Company). This study assumes during the study period this dealings mechanism which currently applied was active. 3- Jordan is paying the market price of Saudi Arabia Light Crude for all its petroleum imported quantities.

The output of the hedging simulation will be compared to investigate the impact of using futures contracts, as a hedging strategy, to hedge the Jordanian petroleum against volatility risk and cost invoice increasing . The main feature of this hedging simulation is Cross Hedging method; because there are no available futures contracts on the same crude underlying the hedging i.e., there is no futures contracts on Saudi Arabian Light Crude at the futures market, the futures contracts that will be used in the study will be the after –one-month maturity contract Cushing OK Crude Oil Futures Contract1 (OK Futures Contract 1) and, the after - four-month maturity contract for the same futures (OK Futures Contract 4). Cushing OK Crude Oil Futures contracts are traded at NYMEX. The reason behind using that futures at that market is because there aren't available historical price for other Crude futures, like BRENT contract of IPE or Oman contract of DME. The estimation procedures for the hedging performance will depend on constant hedge approach rather than time-varying hedge approach, that means the hedge ratio will not vary across the hedge duration. It should be noted that constant hedge approach is used rather than time-varying because at NYMEX oil futures for which the constant performs better (Alizadeh et al., 2004: 1350).

5.3 The Study Period: The study period extends for ten years staring from January 1, 1998 and ended in December 31, 2007. Relatively , it is sufficient period to produce valid results. Furthermore, through this period there are diverse events related with the petroleum prices happened in the world, that represents unitary in the impact of the market powers and guarantee the true environment to conduct this study.

5.4 The Study Sample: To conduct the hedging simulation on the Jordanian Petroleum costs, and to execute the necessary comparisons in both cases, costs and volatility by hedging and without, it is necessary to obtain the following data:

1- The monthly imported quantities of crude oil for Jordan during the study period 1998-2007.

2- Weekly spot prices of Saudi Arabian light crude over the study period. These prices are available in appindex1.

3- Daily futures prices of NYMEX Cushing OK Crude Oil Futures; Contract 1 represents the second month delivery (nearby futures contract maturity) for crude oil, each contract expires on the third business day prior to the 25th calendar day of the month preceding the delivery month.(7)

4- Yearly interest rates for treasury–constant-maturities for U.S. securities.

All the data above obtained from Jordan Petroleum Refinery Company; NYMEX; U.S. Energy Information Administration EIA and Federal Reserve Statistical Release.

5.5 Hedging Mechanism: Cross hedging is typically used when the asset whose price is too be hedged may not be the same as the asset underlying the futures contract. Therefore, the hedge will not be perfect, and its performance will be less efficient . For the time being there aren't trading futures contract on Saudi Arabian Light Crude to guarantee a perfect hedge. Therefore, OK Futures at NYMEX will be used to conduct cross hedging simulation for the Jordanian purchases cost of Saudi Arabian Light Crude.

At the end of each month, Jordanian government purchases the petroleum needs of the next month from Saudi Arabian Light Crude at the spot price of the date corresponding with the settlement date of OK Futures Contract 1 (when contract 1 hedging is used) and OK Futures Contract 4 (When contract 4 hedging is used).

Hedging performance will depend on price movement at both spot and futures markets, that is, the outcome of futures position will be added to the spot position. For example assume that at 21-Sep.2007 Jordan Petroleum Company taken a long position on OK Futures Contract at NYMEX, at that date the futures price F0 was \$81.62, Whereas, at the settlement date 22-Oct. 2007 the settlement price FT was \$ 87.56, the net profit (loss) of the futures position is \$5.94 as follow:

$$FT - F0 \quad \ldots\ldots (1)$$

At the settlement date the spot price ST of Saudi Arabian Light Crude was \$81.43, that means that at the ordinary case (without hedging) Jordanian government will pay \$81.43, but the realized price by hedging through OK Futures Contract will be \$75.49 as follows:

$$RP = ST + F0 - FT \quad \ldots\ldots (2)$$

Rp : Realized price

By cross hedging, the hedgers in oil markets take futures positions on underlying crude which its futures prices related with spot prices of crude being hedged that is, the achieved profit of futures position will contribute to reduce the losses of spot position, or the achieved profit of spot position will contribute to reduce the losses of futures position[(8)] (Chance and Brooks,2008:361).

5.6 Simulation Conducting: According to the monthly quantities of the imported petroleum which obtained from Jordan Petroleum Refinery, there are three cases for the output of simulation . First, when the Jordanian government keeps the costs unhedged. Second, when the futures contract used to hedge the Saudi Arabian Light Crude over the study horizon is OK Futures Contract 1 (one

month maturity contract). And Third, when the contract used to hedge the Saudi Arabian Light Crude is OK Futures Contract 4 (four months maturity contract). In order to determine the hedge size, the study uses the settlement price movements for each contract of Cushing OK Crude Oil Futures; the spot price movements of Saudi Arabian Light Crude over the study horizon and the hedge ratio model. These different sources of data will result in output of simulation that will reflect the hedged and unhedged cost for the Jordanian imported petroleum.

5.6.1 Procedures to Estimate the Hedge Ratio: One of the most important factors that determines the nature and size of the output of hedging performance is hedge ratio. To generate a suggested logical ratios to determine the hedge size for the Jordanian purchased petroleum there are three minimum –variance models used in this study:

5.6.1.1 One to One Hedge Ratio Model. According to this model the hedge will cover all of the spot position size , that means *h=100%*.(to avoid replication see equation 6).

5.6.1.2 Minimum Variance Models. There are many approaches to compute the minimum variance hedge ratios other than the previous one. The researchers will use two models to generate a logical percentage for hedging the monthly quantities of the imported petroleum of Jordan:

Chance model (Chance and Brooks,2008: 366)

$$N_f^* = \rho_{\Delta S,\Delta f} \frac{\sigma_{\Delta S}}{\sigma_{\Delta f}} \quad \text{..........................(3}$$

N*f is the hedge ratio that minimizes the variance of the hedge's position. Δs is the change in the spot price of the asset during a period of time equal to the life of the hedge. Δf is the change in futures price of the underlying asset during a period of time equal to the life of the hedge. σΔs the standard deviation of Δs. σ Δf is the standard deviation of Δf. ρ Δs, Δf the coefficient of correlation between Δs and Δf.

McKinnon Model

(McKinnon, 1967: 847)

$$h = \frac{\left(\frac{\rho \bar{s}_0 \sigma_q}{\sigma_{s0}} + \bar{q} + \frac{\mu_{ik}}{\sigma_{s0}^2} \right)}{q} \quad \text{.............................(4)}$$

where q is the quantity of commodity to hedge, S0 is the spot price, and $\bar{q}$, σ^2_q , $\bar{S}_0$ and σ^2_{s0} are means and variances of q and S_0 respectively, and

$$\mu_{ik} = e\ [(\bar{S} - S_0)^i\ (q - \bar{q})^k\ ] \quad \text{…………………(5)}$$

for i , $k \geq 1$, are the bivariate moments from the joint density function , (S_0q): $\mu 11$ is the covariance between price and quantity that can be written as $\rho_{S0}\ \sigma q$ *where* ρ is the correlation coefficient between $_{S0}$ and q .

5.6.2 Estimation of the Hedged Cost Under One to One Hedge Ratio: when the hedge ratio is One to One (h1 = 100%) all quantity of the month hedged by futures contracts, so, all quantity of the month will be priced on the realized price basis as a result for hedging action considering additive cost as a result for initial margin deposit, it can be computed by interest rate on the initial margin which approximately equal 8% from the futures price .

$$\text{Hedged Cost} = q_i * RP_i + (0.08* RP_i * r_i^{(9)} \quad \text{…………(6)}$$

5.6.3 Estimation of Hedged cost Under Minimize Variance Hedge Ratio Model: When the hedge ratio is belong to minimize variance hedge ratio models, the hedge ratio will be 1≥ h or h ≥ 1. In the case of hedge ratio smaller than one, the hedged quantity will be less than month's quantity, that means the cost of residual unhedged quantity will be computed according to the spot market by the ordinary way (without hedging). In contrast, if the hedged ratio greater than one, the excess of hedging size will conducted from the spot position size, that means the additive impact of the excess hedging in the futures market will reduce the impact of spot prices on the spot market. In the case of hedge ratio equal 1 the equation is the same as the previous section

$$Hedged\ Cost = (h \times q_i \times RP_i) + ((1-h)q_i \times S_T) + (h \times 0.08 \times RP_i \times r_i) \text{…(7)}$$

(Rahgozar and Najafi, 2003:143)

5.6.4 Estimation of Hedging Effectiveness: which reflects the percentage of the cost risk that can be eliminated under each contract is the ratio of the changes in the standard deviation between the unhedged cost $sd(c^0)$, and the standard deviation of the hedged costs, $sd(c^h)$, divided by the standard deviation of the unhedged costs,

$$e* = [\ sd(c^0) - sd(c^h)\ /\ sd(c^0)\ ] \text{……………………………………(8)}$$

where: (Chance and Brooks, 2008:366)

$e*$ is the hedging effectiveness.

5.6.7 Paired-Samples T- test

The paired-samples T-test procedure compares the means of two variables for a single group. The procedure computes the differences between values of the two variables for each case and tests whether the average differs from 0. Thus, each subject has two measures, often called before and after measures. This test include statistics for each variable: mean, sample size, standard deviation, and standard error of the mean. For each pair of variables the following features should be calculated: correlation, average difference in means, T- test, and confidence interval for mean difference standard deviation and standard error of the mean difference.

6. The Results

6.1 The Results of the Unhedged Choice

According to the assumptions of the simulation in the Jordanian petroleum context, and depending on the published spot prices for Saudi Light Crude Oil, the monthly costs for the monthly imported quantities during the period 1998-2007 are shown in Table (1). By this choice Jordan will be under the petroleum market powers (real prices as it published in the oil markets). That means the unhedged choice will retain the risk as it be and bearing the consequences either good or bad.

Table (1)Estimated Monthly Costs (Unhedged) $q_i \times S_T$

Month	Cost ($)	Month	Cost ($)	Month	Cost ($)
Jan-98	34,358,000	Jan-99	23,060,100	Jan-00	55,700,000
Feb-98	13,480,400	Feb-99	23,077,220	Feb-00	59,138,640
Mar-98	26,682,700	Mar-99	21,503,460	Mar-00	49,562,700
Apr-98	18,272,800	Apr-99	25,866,050	Apr-00	60,524,250
May-98	30,874,680	May-99	33,928,200	May-00	55,435,260
Jun-98	26,188,800	Jun-99	24,919,740	Jun-00	48,132,700
Jul-98	25,374,120	Jul-99	28,196,520	Jul-00	40,037,200
Aug-98	65,496,000	Aug-99	31,618,720	Aug-00	64,972,740
Sep-98	27,637,500	Sep-99	46,579,050	Sep-00	70,375,000
Oct-98	29,820,000	Oct-99	54,213,310	Oct-00	90,074,530
Nov-98	29,730,630	Nov-99	45,621,000	Nov-00	82,224,770
Dec-98	24,704,960	Dec-99	66,122,700	Dec-00	78,300,040

Month	Cost ($)	Month	Cost ($)	Month	Cost ($)
Jan-01	61,025,250	Jan-02	43,884,000	Jan-03	63,629,280
Feb-01	56,992,860	Feb-02	36,474,750	Feb-03	68,290,560
Mar-01	59,199,420	Mar-02	46,563,000	Mar-03	70,352,730
Apr-01	57,947,100	Apr-02	54,299,700	Apr-03	64,630,050
May-01	63,402,990	May-02	53,522,760	May-03	57,972,840
Jun-01	65,962,510	Jun-02	21,491,820	Jun-03	42,793,080
Jul-01	36,505,600	Jul-02	47,654,160	Jul-03	54,842,350
Aug-01	53,624,870	Aug-02	78,259,500	Aug-03	62,991,880
Sep-01	60,675,720	Sep-02	67,078,820	Sep-03	52,707,240
Oct-01	64,144,890	Oct-02	70,569,040	Oct-03	58,793,290
Nov-01	47,319,400	Nov-02	63,865,590	Nov-03	58,302,720
Dec-01	40,608,800	Dec-02	51,954,660	Dec-03	73,745,400
Jan-04	79,172,270	Jan-05	66,287,680	Jan-06	143,871,000
Feb-04	74,436,400	Feb-05	69,700,120	Feb-06	170,147,700
Mar-04	81,992,000	Mar-05	83,720,700	Mar-06	169,015,880
Apr-04	81,107,770	Apr-05	91,161,450	Apr-06	119,693,040
May-04	62,948,280	May-05	76,091,450	May-06	164,281,390
Jun-04	76,624,040	Jun-05	53,265,940	Jun-06	157,431,200
Jul-04	82,598,180	Jul-05	94,527,540	Jul-06	160,517,380
Aug-04	92,568,900	Aug-05	94,527,540	Aug-06	184,908,240
Sep-04	94,050,540	Sep-05	119,688,800	Sep-06	171,879,600
Oct-04	93,530,160	Oct-05	177,190,200	Oct-06	139,216,800
Nov-04	118,191,150	Nov-05	140,878,080	Nov-06	142,044,540
Dec-04	109,607,940	Dec-05	116,968,800	Dec-06	135,894,560
Jan-07	145,281,580	May-07	97,063,380	Sep-07	165,692,340
Feb-07	128,629,410	Jun-07	91,964,000	Oct-07	209,374,680
Mar-07	128,187,800	Jul-07	187,982,200	Nov-07	233,704,100
Apr-07	127,598,460	Aug-07	226,474,920	Dec-07	244,044,960

6.2 Results of Using Cushing OK Crude Oil Futures Contract1

6.2.1 Estimated Hedge Ratios for Contract1

Depending on the hedge ratio determination models, table (2) shows the suggested hedge ratios for each model. These ratios determine the number of Cushing OK Crude Oil Futures Contracts (after-one-month maturity contract) that required to hedge the Jordanian petroleum imported quantities represented by Saudi Arabian Light Crude, during the period of 1998-2007.

Table (2) Estimated Hedge Ratios for Contract 1

	1998 %	1999 %	2000 %	2001 %	2002 %	2003 %	2004 %	2005 %	2006 %	2007 %	98-07 %
h1	100	100	100	100	100	100	100	100	100	100	100
h2	91	11	5	2	22	3	63	13	20	15	4
h3	132	116	161	81	124	114	85	178	80	135	108

h1: One-to-One Hedge Ratio Model (Equation 6)

h2: Chance Model (Equation 3)

h3: Mckinnon Model (Equation 4)

Except the constancy of One-to-One model, all suggested ratios for the hedge size are varying across the used model and the hedge time; that difference referring to the model construction, the movement of spot and futures prices, and the monthly quantities changes. Consequently, the amount and the nature of the output of hedging strategy will vary depending on the used model. Certainly, an ideal model is one that reduce the volatility risk as well as reduce the cost amount.

6.2.2 Results of Hedging Effectiveness Under Contract 1

After conducting four scenarios to estimate the Jordanian petroleum hedged costs according to suggested ratios for each model, the following are summarized results for hedging effectiveness of using Cushing OK Crude Oil Futures Contract1 in hedging the Jordanian petroleum costs represented by Saudi Arabian Light Crude.

6.2.2.1 Results of Hedging Effectiveness in Cost Risk under Contract 1

Table (3) shows the ability of hedging to reduce the volatility risk of the petroleum cost. These percentages reflect the volatility risk of the Jordanian petroleum costs that can be eliminated under each model using Cushing OK Crude

Oil Futures Contract1(nearby month maturity). The negative ratios mean reduction in risk, whereas positive sign means raising in risk.

Table (3) Hedging Effecti veness in Cost Risk Reduction Using Cushing OK Crude Oil Futures Contract 1

	1998 %	1999 %	2000 %	2001 %	2002 %	2003 %	2004 %	2005 %	2006 %	2007 %	98-07 %
h1	+1.95	-16.08	-7.00	+8.54	-0.74	+36.44	+19.82	+3.92	+9.43	-17.38	-2.26
h2	+1.58	-2.12	-0.98	-0.59	-1.07	-0.28	+8.53	0	-4.60	-3.25	-0.18
h3	+3.53	-17.84	+2.32	+1.16	+0.65	+46.80	+14.78	+12.73	+1.42	-20.49	-2.25

From the above table , using Cushing OK Crude Oil Futures Contract, one-month maturity, there are side effects possibility; although, all entire period ratios in the last column, and limited percentages limited positive outputs (negative sign).

6.2.2.2. Results of Hedging Effectiveness in Cost amount under Contract 1

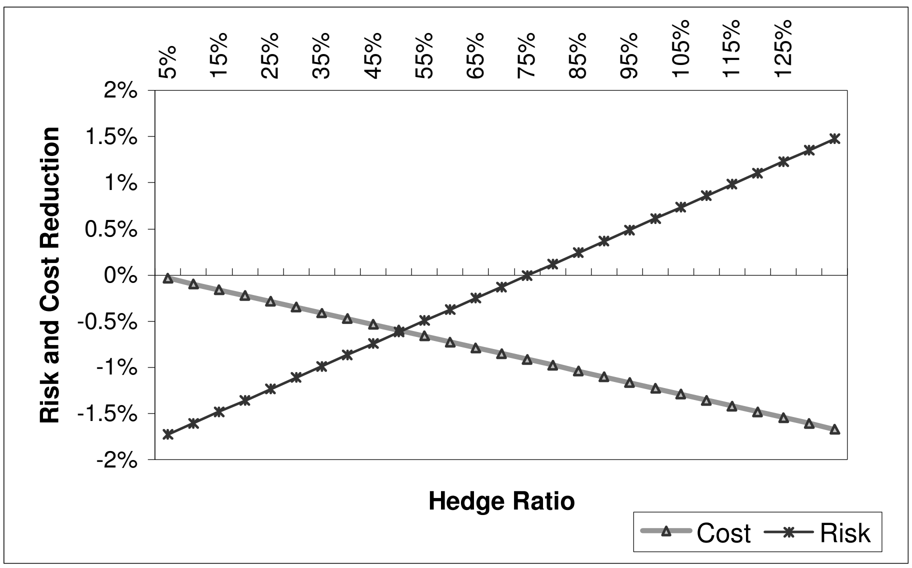
The results shown in table (4) are referring to the ability of hedging strategy in reduction the amount of the Jordanian imported petroleum costs using Cushing OK Crude Oil Futures Contract1(nearby month maturity). The negative ratios in table implies a costs decrease, while positive ratios means increase in the costs.

Table (4) Hedging Effectiveness in Cost Reduction Using Cushing OK Crude Oil Futures Contract 1

	1998 %	1999 %	2000 %	2001 %	2002 %	2003 %	2004 %	2005 %	2006 %	2007 %	98-07 %
h1	+7.26	-6.09	-2.79	+3.57	-2.63	-5.04	-5.75	-0.31	+1.92	-3.42	-1.63
h2	+6.61	-0.67	-0.14	+0.07	-0.58	-0.15	-3.62	-0.04	+0.38	-0.59	-0.07
h3	+9.59	-7.06	-4.49	+2.89	-3.26	-5.74	-4.89	-0.56	+1.54	-5.29	-1.76

It is clear that using Cushing OK Crude Oil Futures Contract1, after-one-month maturity, in hedging the Jordanian monthly quantities costs of imported petroleum points out inverse results possibility; although, all entire period results in the last column, and seven hedged years, reveal desired negative-sign-percentages.

By conducting a regression for hedging effectiveness, for the risk and cost, on hedge ratios for all models a brief description for hedging performance depicted in Figure (1). It is clear that the effect of hedging on volatility risk and costs using Cushing OK Crude Oil Futures contract1 has a desirable reduction on the petroleum costs and undesirable increasing on volatility risk.



Figure(1)

Effect of hedging on volatility risk and cost using after-one-month maturity contract of Cushing OK Crude Oil Futures Contract 1

6.2.3 Result of The First Hypothesis

Depending on the previous estimations which are referring to using Cushing OK Crude Oil Futures Contract1, and as shown in Table (3) and Figure (1), it is clear that the after hedging volatility risk is more than before hedging. Therefore the first hypothesis can not be accepted. This result was expected because the basis risk of cross hedging always more than the basis risk when the asset being hedged and the asset underlying the futures contract are the same(Hull, 2000: 37). In the other hand, the volatility risk for the nearby-distances contract maturities is probably more than volatility risk when maturity is more distance. This result is interfering with Ripple and Moosa 2007, but it corresponding with Rahgozar and Najafi 2003.

6.2.4 Result of the Second Hypothesis

Results reveal that the Jordanian petroleum costs has decreased after hedging operation through Cushing OK Crude Oil Futures Contract 1, but the question raised here whether these reduction amount has a significant difference or not?

After tracing the results of hedging performance for both maturities and with all models, whether in the singular years or in the entire study period, it is clear that the best joint-reduction possibility in risk and cost was by McKinnon model (h3). So the estimated hedged costs for the Jordanian imported petroleum cost according to that model will submitted in testing the second and fourth hypotheses. Table (5) lists the estimated monthly hedged costs for the Jordanian imported petroleum during the months of the study period. These costs are the realized costs through hedging by Cushing OK Crude Oil Futures Contract1 in a constant monthly basis and depending on McKinnon model. To conduct T test on SPSS; natural log transform is used to obtain the normality distribution for the estimated hedged costs ,Table (5), and the estimated unhedged costs, Table (1). The Paired-Samples T-test procedure used to compare the costs of the two cases for a single group (Jordanian petroleum costs). The procedure computes the differences between values of the two variables for each case and tests whether the average differs from 0. The test has conducted on a 95% confidence interval for the difference in means.

Table (5) Estimated Monthly Hedged Costs – Contract 1

Month	Cost ($)	Month	Cost ($)	Month	Cost ($)
Jan-98	38,163,142	Jan-99	27,579,374	Jan-00	57,638,455
Feb-98	16,010,288	Feb-99	21,297,587	Feb-00	46,264,474
Mar-98	27,277,151	Mar-99	22,731,481	Mar-00	76,667,461
Apr-98	20,716,942	Apr-99	18,983,083	Apr-00	65,930,374
May-98	34,687,715	May-99	28,157,063	May-00	55,910,470
Jun-98	33,395,487	Jun-99	26,641,829	Jun-00	40,311,062
Jul-98	27,518,574	Jul-99	27,788,927	Jul-00	30,104,836
Aug-98	68,155,656	Aug-99	29,769,314	Aug-00	66,697,067
Sep-98	29,459,874	Sep-99	41,062,275	Sep-00	59,710,291
Oct-98	23,364,395	Oct-99	46,886,374	Oct-00	66,597,443
Nov-98	37,446,496	Nov-99	50,217,368	Nov-00	83,377,563
Dec-98	30,228,636	Dec-99	53,598,912	Dec-00	71,415,713
Jan-01	74,617,320	Jan-02	38,932,678	Jan-03	51,770,179
Feb-01	44,434,033	Feb-02	40,418,926	Feb-03	56,346,619
Mar-01	61,130,086	Mar-02	44,131,169	Mar-03	60,122,157
Apr-01	63,139,887	Apr-02	42,272,687	Apr-03	84,351,300

Month	Cost ($)	Month	Cost ($)	Month	Cost ($)
May-01	62,437,127	May-02	51,635,942	May-03	49,379,713
Jun-01	61,703,656	Jun-02	20,683,536	Jun-03	37,079,073
Jul-01	40,073,101	Jul-02	49,887,193	Jul-03	50,012,937
Aug-01	55,429,018	Aug-02	74,973,847	Aug-03	60,146,395
Sep-01	57,066,047	Sep-02	54,229,148	Sep-03	49,796,485
Oct-01	63,716,057	Oct-02	69,327,558	Oct-03	72,603,229
Nov-01	55,524,385	Nov-02	72,848,088	Nov-03	50,765,978
Dec-01	47,449,590	Dec-02	55,566,178	Dec-03	64,802,838
Jan-04	75,763,395	Jan-05	76,400,509	Jan-06	143,276,793
Feb-04	64,796,566	Feb-05	66,009,765	Feb-06	147,393,902
Mar-04	79,434,138	Mar-05	74,254,618	Mar-06	186,375,711
Apr-04	74,736,879	Apr-05	73,297,946	Apr-06	120,461,906
May-04	62,688,258	May-05	86,395,667	May-06	144,177,928
Jun-04	67,389,602	Jun-05	70,073,999	Jun-06	169,313,808
Jul-04	86,601,884	Jul-05	63,110,876	Jul-06	166,431,716
Aug-04	85,111,218	Aug-05	98,992,834	Aug-06	179,094,227
Sep-04	79,170,409	Sep-05	89,669,472	Sep-06	175,641,308
Oct-04	91,467,531	Oct-05	174,504,585	Oct-06	161,417,816
Nov-04	103,386,263	Nov-05	168,552,633	Nov-06	151,980,111
Dec-04	125,110,892	Dec-05	136,141,003	Dec-06	141,903,530
Jan-07	130,426,031	May-07	89,176,208	Sep-07	184,043,279
Feb-07	174,025,207	Jun-07	93,722,183	Oct-07	156,221,245
Mar-07	118,239,861	Jul-07	178,869,262	Nov-07	210,777,901
Apr-07	137,870,962	Aug-07	197,607,653	Dec-07	209,879,266

Depending on T-test results P- value = 0.160 > 0.05, computed-t = 1.414 where t-tab = 1.980, there is no significant difference between the hedged and unhedged cost, therefore the second hypothesis could not be accepted.

6.3 Results of Using Cushing OK Crude Oil Futures Contract 4

6.3.1 Estimated Hedge Ratios for Contract 4

Similar to that used in estimating hedge ratios for contract1, Table (6) shows the suggested hedge size for each model using contract 4. These ratios determine the number of Cushing OK Crude Oil Futures Contracts4 (after-four-month maturity contract) that required to hedge the Jordanian petroleum imported quantities, represented by Saudi Arabian Light Crude, during the period of 1998-2007.

Table (6) Estimated Hedge Ratios by Contract 4

	1998 %	1999 %	2000 %	2001 %	2002 %	2003 %	2004 %	2005 %	2006 %	2007 %	98-07 %
h1	100	100	100	100	100	100	100	100	100	100	100
h2	93	2	68	29	19	8	0	25	8	39	24
h3	132	116	161	81	124	114	85	178	80	135	108

In the same sense as discussed in contract1, except the constancy of One-to-One model, all suggested ratios for the hedge size are varying across the used model and the hedge time; that difference referring to the model philosophy, the movement of spot and futures prices, and the monthly quantities changes. Consequently, the amount and the nature of the output of hedging strategy by contract4 will varying depending on the used model. As discussed earlier, an ideal hedging is one that reduce the volatility risk as well as reduce the cost amount.

6.3.2 Results of Hedging Effectiveness Under Contract 4

After conducting four scenarios to estimate the Jordanian petroleum hedged costs depending on the suggested ratios for each model, the following are the summarized results for hedging effectiveness from using Cushing OK Crude Oil Futures Contract 4 in hedging the assumed purchases from Saudi Arabian Light Crude through the months of the study period.

6.3.2.1 Results of Hedging Effectiveness in Cost Risk under Contract 4

Hedging findings with contract4 is different compared with contract1, the Jordanian imported petroleum costs herein are hedged through the more distance maturity. Obviously, the after-four-month maturity Cushing OK Crude Oil Futures Contract is more effective in reducing both risk and costs than nearby Cushing OK Crude Oil Futures Contract1. Ratios shown in table (7) describe the yearly hedging effectiveness by contract 4 and for the entire period. All percentages appear in that table are calculated after estimation the hedged costs by each model.

Table (7) Hedging Effectiveness in Cost Risk Reduction Using Cushing OK Crude Oil Futures Contract 4

	1998 %	1999 %	2000 %	2001 %	2002 %	2003 %	2004 %	2005 %	2006 %	2007 %	98-07 %
h1	+5.88	-30.27	-21.63	+10.17	-1.08	-20.12	-28.30	-18.34	+6.72	-29.64	-7.60
h2	+5.33	-0.77	-15.30	-5.12	-3.13	-3.22	0	-5.83	-5.51	-13.25	-2.45
h3	+8.63	-32.83	-31.60	-2.34	+4.15	-18.63	-28.05	-20.75	-7.58	-35.30	-7.84

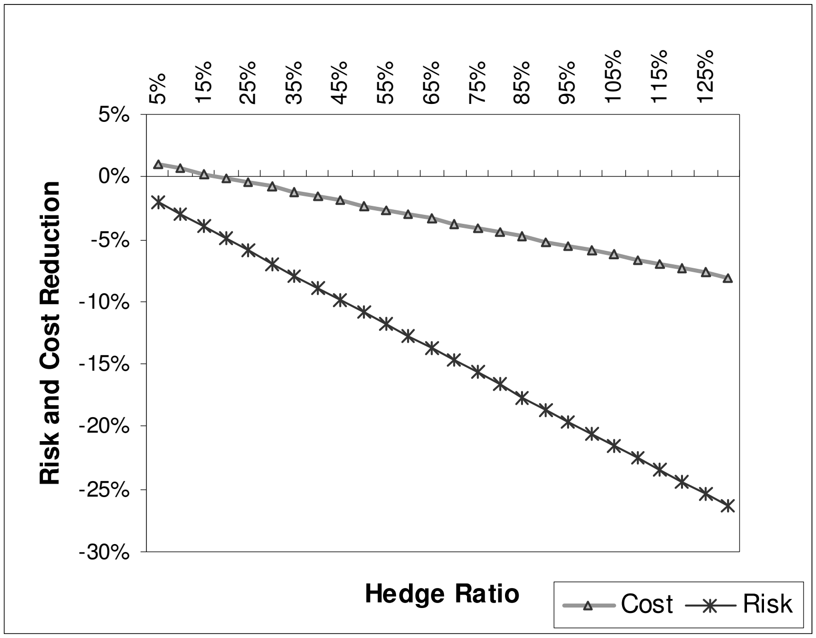
6.3.2.2 Results of Hedging Effectiveness in Costs amount under Contract 4

Table (8) includes the percentages of hedging effectiveness in cost reduction. As mentioned earlier, the ideal hedge is that one which combined the two dimensions, reduction in risk with reduction in cost. Relatively this aim is reached here in most cases but not in all.

Table (8) Hedging Effectiveness in Cost Reduction Using Cushing OK Crude Oil Futures Contract 4

	1998 %	1999 %	2000 %	2001 %	2002 %	2003 %	2004 %	2005 %	2006 %	2007 %	98-07 %
h1	**+14.91**	**-16.58**	**-13.77**	**+2.46**	**-5.15**	**-4.31**	**-19.62**	**-10.56**	**+0.10**	**-6.87**	**-6.03**
h2	**+13.87**	**-0.33**	**-9.09**	**+2.95**	**-0.98**	**-0.35**	**0**	**-2.64**	**+0.01**	**-2.68**	**-1.37**
h3	**+19.68**	**-19.24**	**-21.74**	**+8.24**	**-6.39**	**-4.92**	**-16.68**	**-18.80**	**+0.08**	**-9.27**	**-6.51**

As noted in all ratios related to hedging performance of the petroleum cost for the year of 1998, all ratios of the two maturity contracts and for the four models reveal the failure of hedging in managing the costs risk and costs increasing, conversely, the risk and costs becoming greater than before. The reasons behind that are, firstly, the constant hedge strategy that applied in this study was assumed hedging continuance without responding to cash and futures prices movements. Secondly, the risk related to the cross hedging by using Cushing OK Crude Oil as an underlying crude of futures contract to hedge the Saudi Light Crude is more risky than hedging when the two asset are the same.



Figure(2) Effect of hedging on volatility risk and cost using Cushing OK Crude Oil Futures Contract 4

By conducting a regression for hedging effectiveness, for the risk and cost, on hedge ratios for all models a brief description for hedging performance depicted in Figure (2). It is clear that the effect of hedging on volatility risk and costs using Cushing OK Crude Oil Futures contract4 (after-four-month maturity contract) has a desirable reduction in the volatility risk and petroleum costs.

6.3.3 Result of the Third Hypothesis

Depending on the percentages that shown in table (7), except the year of 1998 and the limited figures on other years, all percentages of hedging effectiveness point out a reduction on the volatility risk. For example, according to McKinnon model(h3), the hedging performance record -32.8%, -31.6% , -2.34%, -18.6%, -28%, -20.7%, -7.6%, -35.3% for eight years from the ten years of study period. Figure (2) illustrates the effect of the hedging on risk and costs, confirms the hypothesis that using Cushing OK Crude Oil Futures Contract4 lead to reduce the volatility risk related to the Jordanian petroleum costs. Therefore, the third hypothesis can not be rejected. This result also corresponding with Rahgozar and Najafi 2003 and interfering with Ripple and Moosa 2007.

6.3.4 Result of The Fourth Hypothesis

Obviously, the Jordanian petroleum costs has decreased after hedging operation through Cushing OK Crude Oil Futures Contract4, as shown in table (8). Not all percentages reflect desirable hedging performance, but there are relatively acceptable reduction in the Jordanian petroleum costs. Figure (2) sustains that the fourth-month futures of Cushing OK Crude Oil Contract will reduce the Jordanian petroleum costs. As discussed earlier, the question herein whether the size of that reduction reflect a significant difference or not?

Table (9) Estimated Monthly Hedged Costs/ Contract 4

Month	Cost ($)	Month	Cost ($)	Month	Cost ($)
Jan-98	37,243,581	Jan-99	30,253,940	Jan-00	43,917,604
Feb-98	17,400,408	Feb-99	28,407,183	Feb-00	45,528,487
Mar-98	39,004,713	Mar-99	27,177,400	Mar-00	34,149,800
Apr-98	29,197,165	Apr-99	21,085,745	Apr-00	52,294,975
May-98	38,469,722	May-99	20,742,807	May-00	51,586,212
Jun-98	28,943,200	Jun-99	16,677,592	Jun-00	41,346,615
Jul-98	29,490,591	Jul-99	17,616,771	Jul-00	34,327,881
Aug-98	74,594,182	Aug-99	22,998,065	Aug-00	52,821,027
Sep-98	33,648,427	Sep-99	34,157,976	Sep-00	47,902,253
Oct-98	29,478,854	Oct-99	38,071,047	Oct-00	61,878,253
Nov-98	35,906,469	Nov-99	36,287,794	Nov-00	67,873,655
Dec-98	28,645,793	Dec-99	49,529,598	Dec-00	56,851,199
Jan-01	68,906,956	Jan-02	62,212,653	Jan-03	60,182,013
Feb-01	65,083,386	Feb-02	53,822,846	Feb-03	63,486,503
Mar-01	66,462,177	Mar-02	51,196,771	Mar-03	57,276,940
Apr-01	69,356,127	Apr-02	35,527,569	Apr-03	61,113,891
May-01	57,329,336	May-02	37,524,743	May-03	61,201,749
Jun-01	61,668,682	Jun-02	14,356,722	Jun-03	48,677,838
Jul-01	37,500,689	Jul-02	35,362,931	Jul-03	63,801,162
Aug-01	55,618,539	Aug-02	75,222,877	Aug-03	54,427,737

Month	Cost ($)	Month	Cost ($)	Month	Cost ($)
Sep-01	63,754,448	Sep-02	60,148,506	Sep-03	42,562,322
Oct-01	68,714,127	Oct-02	59,570,027	Oct-03	59,401,025
Nov-01	55,022,552	Nov-02	58,020,653	Nov-03	54,239,966
Dec-01	52,980,508	Dec-02	52,049,092	Dec-03	66,826,721
Jan-04	75,448,102	Jan-05	63,575,919	Jan-06	162,281,586
Feb-04	58,263,656	Feb-05	67,391,849	Feb-06	165,501,705
Mar-04	71,756,672	Mar-05	87,784,266	Mar-06	160,948,729
Apr-04	68,540,401	Apr-05	57,623,572	Apr-06	111,130,213
May-04	53,901,856	May-05	46,358,799	May-06	134,422,467
Jun-04	64,022,391	Jun-05	47,932,384	Jun-06	153,406,719
Jul-04	70,227,260	Jul-05	66,894,448	Jul-06	146,638,078
Aug-04	92,018,189	Aug-05	89,098,542	Aug-06	160,476,662
Sep-04	71,030,938	Sep-05	82,821,357	Sep-06	176,483,517
Oct-04	79,628,883	Oct-05	95,326,841	Oct-06	160,901,828
Nov-04	81,804,370	Nov-05	137,336,635	Nov-06	162,757,850
Dec-04	85,574,046	Dec-05	119,258,103	Dec-06	165,414,919
Jan-07	177,845,973	May-07	96,821,818	Sep-07	164,375,655
Feb-07	163,805,732	Jun-07	73,056,927	Oct-07	167,154,734
Mar-07	135,895,534	Jul-07	158,186,538	Nov-07	178,574,153
Apr-07	130,379,296	Aug-07	174,778,666	Dec-07	180,938,197

Depending on McKinnon model, Table (9) reflects the estimated monthly hedged costs by Cushing OK Crude Oil Contract4. After using natural log transform to obtain the normality distribution for the estimated hedged and unhedged costs that required to conduct the T test on SPSS, the Paired-Samples T-test procedure used to compare the costs of the two cases for a single group(Jordanian petroleum costs). The procedure computes the differences

between values of the two variables for each case and tests whether the average differs from 0. The test has conducted on a 95% confidence interval for the difference in means.

According to T test results, P- value = 0.000 < 0.05, computed T = 3.865 where T- tab. = 1.980; there are a significant difference between the hedged and unhedged cost, therefore the fourth hypothesis can not be rejected.

7. Conclusions and Recommendations

This part presents the overall conclusions of the study and the propounded recommendations that derived from literature survey and simulations results in the previous sections.

Conclusions

Depending on the study objectives and according to the study questions the researcher has reached the following conclusions:

1. There are a universal interest by futures markets, expansion in a new markets, and diversity of financial engineering tools.
2. The constant cross hedge strategy with the more-distant-maturity futures contracts proved to be successful in hedging the Jordanian petroleum purchases against price volatility.
3. The constant cross hedge strategy with the more-distant-maturity futures contracts proved to be successful in reducing the Jordanian petroleum cost invoice.
4. The less maturity futures contract will increase the price risk.
5. Longer time to maturity and higher hedge ratios have positive impact in reducing cost risk and cost amount.
6. The most appropriate model in determining the hedge ratio of the Jordanian petroleum purchases is McKinnon Model.

Recommendations

Recommendations for the energy decision makers in Jordan : The researcher recommends the energy policymakers in Jordan to assess the merits of futures contracts for managing risk related with the petroleum price risk. For the time being, there aren’t futures contracts on Saudi Arabian Light Crude (the imported crude of Jordanian needs) the researcher recommends energy policymakers in Jordan to exploit the cross-hedge strategy by different oil futures, at New York Mercantile Exchange NYMEX, International Petroleum Exchange IPE, or Dubai Mercantile Exchange DME, to manage the Jordanian imported petroleum price risk.

Recommendations for future researchers: The aim of this study is to propound a solution for the oil price risk in Jordan through futures contracts, the researcher recommends studying the effect of other derivatives tools, like options on futures, in managing that risk. The researchers recommends using the time varying approach instead of constant approach in hedging the Jordanian imported petroleum costs by futures or employing other different futures contracts maturities like six, nine months and one year in different oil markets such as Dubai Mercantile Exchange, and conduct a comparison between the results of the two approaches to determine the most appropriate for Jordanian context.

employing other different futures contracts maturities like six, nine months and one year in different oil markets such as Dubai Mercantile Exchange.

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Foot

(1) Oil or petroleum will be used interchangeably to indicate the same thing

(2) *Basis risk* describes the lack of correlation that may exist between the price of a derivative contract and the price of the commodity that is being hedged. To the extent that these prices move independently, the hedger faces a risk that the change in the value of the physical position may not be entirely offset by the change in the value of the derivative position. Thus, the hedge may not be a perfect one.

(3) Successful petroleum futures contacts first appeared in 1978, when NYMEX introduced futures contracts on both No. 2 heating oil and No. 6 fuel oil. The No. 6 contract failed but the No. 2 contract has been successful because heating oil is bought and sold by a large number of market participants (EIA: Energy Information Administration – U.S. Department of Energy, 2002:23).

(4) OTC instruments bridge the gap between the short-term futures market and the longer-term requirements of consumers, as well as offer a tailor-made solution to the problem of hedging products when there is no active futures market or when a company prohibits direct dealing in the futures market.

(5) The fuel of the ships.

(6) Actually , in the few recent years, Jordanian government ,through the Jordan Petroleum Refinery Company, purchases its needs from Saudi Arabia. Prior to the Iraqi war in 2003, Jordan received supplies of crude oil from Iraq half free- of charge, and have at prices significantly below market levels. Kuwait and Saudi Arabia had provided discounted oil as a stopgap measure through 2004.

(7) If the 25th calendar day of the month is a non-business day, trading ceases on the third business day prior to the business day preceding the 25th calendar day.

(8) In some cases, the price of the asset being hedged and that of the futures contract move in opposite direction. Then a hedge will produce either a profit or a loss on both the spot and the futures positions. If one chooses the correct futures contract, this is unlikely to occur. If it occurs frequently, the hedger should find a different contract (Chance and Brooks, 2008:361).

(9) The Effective market monthly interest rate.

(3)
(6)

(7)
(8)

(9)